From the Table to Waste: an Exploratory Study on Behaviour towards Food Waste of Spanish and Italian Youths

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FROM THE TABLE TO WASTE: AN EXPLORATORY STUDY ON BEHAVIOUR TOWARDS FOOD WASTE OF SPANISH AND ITALIAN YOUTHS

Abstract

Over the last few years, much attention has been paid to the phenomenon of household food waste which largely contributes to the total amount of food waste generated in industrialised countries. The reduction of food waste has been also included within the European strategy of circular economy and ambitious objectives have been assigned to the European member states.
Youths proved to be the segment of the population most inclined to waste food and therefore need to be monitored. This exploratory study, based on a survey involving 380 youths residing in Italy and Spain, aims at investigating the complex food waste behaviour within the framework of the Theory of Planned Behaviour.
By referring to the PLS-SEM approach, we analyze the validity of the relationships between individual habits, attitudes, addiction towards marketing and sale strategies and behaviour towards food waste. We also aim at verifying the existence of mediator effects in order to better understand these relationships. Moreover, the construction of the Importance Performance Matrix Analysis enables us to identify the dimensions which greatly influence a positive behaviour and for which urgent attention and interventions are required.
Our results confirm that behavioural models are appropriate for explaining youths' behaviour towards food waste with an important role played by the perceived behavioural control. On the other hand, situational factors which characterize the moment of purchase should be carefully considered and monitored. In fact, marketing and sale strategies negatively influence the conservative food waste behaviour of individuals thus emphasizing the important role of retailers in preventing the generation of food waste.

Key words: food waste, circular economy, youths, Theory of Planned Behaviour, PLS-SEM

1.Introduction

In recent years, policy makers and institutions at various administrative levels have been focusing on the issue of food loss at consumption stage, the phenomenon known as *food waste*[1] (FW) which occurs above all in developed countries (Gustavsson et al., 2011; Katajajuuri et al, 2014; Principato et al, 2015; Miliute-Plepiene et al, 2015).
At European level, the European Commission is taking measures to reduce the amount of food wasted since it will save money, lower the environmental impact of food production and consumption as well as preventing the social impacts related to this phenomenon (Beretta et al., 2013; Quested et al, 2013; Graham-Rowe et al, 2014; Garrone et al., 2014; Göbel et al, 2015).
The reduction of waste has also been addressed by the EU within the strategy of circular economy, aimed at transforming Europe into a more competitive resource-efficient economy. To this respect, the European Parliament recommended that practical measure should be taken in order to halve food waste by 2025.
Despite the high level of attention towards this issue as well as numerous initiatives within EU countries, it has been estimated that household food waste at European level amounts approximately

[1] In this study we concentrate on household food waste, which includes home-grown food and beverages, food purchased from shops and takeaways and consumed within the home (the United Kingdom Waste & Resources Action Programme, WRAP, 2009). There are two classifications for household food waste: i) avoidable and possibly avoidable waste which includes the "edible" food thrown away and ii) unavoidable food waste which is waste deriving from food preparation that is not, and was not edible (WRAP, 2009; Parfitt et al., 2010) such as bones, shells and skins. This study focuses on avoidable and possibly avoidable food waste.

to 42% of all the food produced (Monier et al, 2011) and two thirds of this amount refers to avoidable and possibly avoidable food waste.
In order to limit this phenomenon surveys and research have been carried out to identify factors associated with FW at consumption level. It was observed that EU-28 youths aged 15-24 are the segment of the population most inclined to waste and therefore they need to be monitored more carefully (FAO, 2012) since they are likely to waste more than 6% of the food they purchase per week (European Commission, 2014).
As a result, educating youths towards a correct behaviour oriented to plan their purchase (in the pre-consumption stage) as well as to re-use their leftovers (in the post-consumption stage) can contribute to limit this issue. However, it is not enough to focus on socio-demographic characteristics since recent studies have demonstrated that this type of behaviour is triggered by personal attitudes, intentions, household habits as well as the context in which the purchase is made (Quested et al, 2013). Moreover, this type of behaviour is not simple to understand since it is the result of a series of activities which originate from the moment of planning food purchases.
It is therefore essential to have an in-depth understanding of the factors driving food waste-related consumer perception and behaviour, both in the household as well as at the point of purchase (Aschemann-Witzel et al., 2015). Parfitt et al (2010) stressed that as FW mainly occurs at the end of the Food Supply Chain, retailers, food services and consumers are those who are able to reduce FW in the developed world.
Our exploratory study focuses on two groups of youths residing in Italy and Spain where there is a high adherence to the Mediterranean Diet – a dietary pattern recognized as an environmentally-sustainable diet which is characterized by a high consumption of perishable products such as fish, fruits and vegetables – and therefore it is important that their purchase must be correctly planned, stored and consumed in order to avoid generating waste.
By adopting the Partial-Least Squares Structural Equation Modelling (PLS-SEM) which has been used for analysing social consumer behaviour and waste behaviour, this paper has a three-fold aim.
Firstly, inspired by the Theory of Planned Behaviour (TPB) introduced by Ajzen (1991) which has proved to have a central role in explaining social consumer behaviour it is essential to determine the validity of the relationships between the "classical" TPB components – Intention, Attitude, Social Norms and Perceived Behavioural Control – and the correct ("conservative") behaviour towards food waste. Moreover, we aim at assessing if and to what extent marketing and sales strategies can affect individuals' behaviour towards FW.
As a novelty in the analysis concerning FW behaviour, this study extends the PLS-SEM results as an opportunity to gain knowledge and development on this important topic.
Secondly, by extending the PLS-SEM results we aim at exploring if the Intention of reducing waste could act as a *mediator* in the relationships between each TPB component and behaviour, by means the mediation analysis.
Thirdly, the Importance Performance Matrix Analysis (IPMA) is constructed in order to facilitate discussion and draw conclusions by identifying the components (dimensions) characterized by a high level of importance and a high/low level of performance. In fact, focusing on these factors can assist policy makers to implement activities, education campaigns with the aim of contrasting the FW phenomenon.
The remainder of the paper is structured as follows. The theoretical framework, the studied positive behaviour towards FW and the Research Hypotheses (RHs) are presented in section 2. Section 3 reports summary information of the data collected in Italy and Spain and illustrates the specified PLS-SEM. In Section 4 the PLS-SEM results are presented and the mediation analysis and IPMA are carried out. In Section 5 the results are discussed and ideas for further research are provided.

2. Background

2.1 The Theory of Planned Behaviour and the proposed extended framework

Since FW at consumer level is a recent research topic, the factors driving FW are still under analysis and discussion (Principato et al., 2015).
Previous research has demonstrated that there are many reasons and multiple types of behaviour which cause food waste which can be considered as a complex behaviour (WRAP, 2011b; Quested et al, 2013). It is therefore not an easy task to find a one-fit-all framework that can explain this issue. Quested et al. (2013) suggested that a model for analysing FW behaviour must bear in mind the context in which behaviour occurs, the individuals' awareness of FW, their attitudes and values, motivation, habits, subjective norms and perceived behavioural control. We therefore decided to start constructing our conceptual framework from the Theory of Planned Behaviour (TPB) proposed by Ajzen (1991).
The TPB hypothesizes that intentions to perform behaviour can be predicted by attitudes, subjective norms and perceived behavioural control. The key principle of the TPB is that Intention strongly influences behavioural performance. The TPB proposed by Ajzen (1991) as an extension of the theory of reasoned action (Ajzen and Fishbein, 1980; Fishbein and Ajzen, 1975), is a prominent framework in the studies aimed at predicting consumer decisions concerning the minimization and recycling of waste (Biswas et al, 2000; Knussen et al. 2004; Davis et al, 2006), as well as at studying various types of food related behaviour (Conner and Armitage, 2002; Rezai et al, 2012), or as a basis for exploring emerging consumer behaviour (Barr et al, 2001).
Furthermore, it was proved that the conceptualization of the relationship between attitudes and behaviour through the TPB seemed to be suitable even when behaviour was self-reported. On this issue, Armitage and Conner (2001) found that when behaviour measures were self-reported, the TPB accounted for 11% more of the variability in behaviour than when behaviour measures were objective or observed.
The TPB also proved to be easily adaptable and flexible for analysing the additional role of concepts not included in the original model (Collins and Mullan, 2011). Regarding the FW issue, Stefan et al (2013) included in the dimension regarding routines and habits related to the everyday food choice in their model. We divided consumers' attitudes towards FW into two groups of measured variables, *moral aspects and concern-based variables* which have already been successfully used by Barr (2007) and Stefan et al. (2013). The moral aspects of attitudes also seem to affect FW since wasting food makes consumers feel guilty (Bolton and Alba, 2012; Evans, 2011; Stefan et al, 2013).
We also hypothesized that the marketing strategies carried out by retailers (such as promotional offers on food products) can affect both the intentions and behaviour of consumers since special offers can lead consumers to purchase excessive quantities of food which is one of the major factors causing FW (Brook Lynhurst, 2007; WRAP, 2007).

2.2. The behaviour under analysis

A "*positive*" behaviour towards FW was created from three activities which can bring about substantial behavioural changes at household level.

Firstly, it is essential *to understand the date-labels on food* which have often been misunderstood by consumers. Recent consumer market surveys in the European Union (EU, 2015) show that only a third of consumers comprehend the meaning of the '*best before*' date. Furthermore, the European Parliament in its resolution of January, 19th 2012 asked "the Commission and the Member States […] to clarify the meaning of the date labels ('best before', 'expiry date' and 'use by') in order to reduce consumers' uncertainties regarding food edibility and to disseminate accurate information to the public, notably the understanding that the minimum durability 'best before' date is related to quality, while the 'use by' date is related to safety, in order to help consumers make informed choices".

Secondly, *it is necessary to consume household leftovers* as this can help to save money and to reduce FW. However education programs concerning the re-use of leftovers are required. In 2009 the Bruxelles Environment (IBGE) organized a series of cooking courses for citizens aimed at helping households to reduce their generation of FW and increase their flexibility in menu planning.

Thirdly, *it is advisable to make a shopping list*. Planning routines can play an important role in reducing unplanned purchase thus limiting FW (Bell, et al, 2011; Stefan et al. 2013; Principato et al. 2015) since failure to check food stocks prior to shopping and to prepare an adequate shopping list are types of behaviour resulting in FW (Chandon and Wansink, 2006; Exodus, 2006; WRAP, 2007).

Individuals who *are able to comprehend expiration dates, re-use of leftovers in new meals* and *plan their purchases by means of a shopping list* can be identified as individuals with a conservative (positive) behaviour towards FW.

The relationships which link this complex behaviour and the various components foreseen by our theoretical framework are illustrated in section 3.2 (Figure 2).

2.3. Research hypothesis

Bearing in mind the complexity of FW behaviour[2] and by considering that the TPB was found to be an appropriate theoretical framework for exploring individuals' activities towards FW generation, we formulated the following Research Hypotheses (RHs):

> **RH1**: Individuals' addiction towards marketing and sale strategies negatively influences both Intention and a Positive behaviour towards FW.
> **RH2**: The direct relationship between Marketing/Sale strategies and Behaviour is mediated by Intention.
> **RH3**: Intention acts as a mediator between its "classical" components (Moral attitude, Concern towards FW, Subjective norms and Perceived Behavioural Control) and positive behaviour.[3]

3. Materials and methods

3.1. Data

The exploratory study refers to a sample of 380 youths. Bearing in mind the aims of our study and to increase the range of competence and understand the main determinants of FW behaviour, the participants were recruited from students enrolled at the University of Tuscia in Viterbo (Lazio region, Italy) and the University of Castilla-La Mancha located in Cuenca (Castilla-La Mancha region, Spain). In the period between November 2014 and March 2015, 200 students were randomly interviewed at the university of Castilla-La Mancha and 180 students at the University of Tuscia. The average age was approximately equal in both subgroups of students (20.73 for Italian students and 20.53 for Spanish students) with an average age of the entire sample of participants equal to 20.62 (standard deviation 2.62). Approximately 58% of participants were female students (56.5% of females in the Spanish sample and 59.22% in the Italian sample).

The participants were asked to fill in a self-administered bi-language (Italian and Spanish) questionnaire composed of 24 questions aimed at investigating the students' knowledge of the problems related to FW as well as their attitudes, habits and behaviour. The questionnaire developed for fulfilling the dimensions of our theoretical framework was divided into four sections. Section 1 includes questions concerning the students' knowledge and level of concern concerning

[2] Quested et al (2013) refer to it as "spaghetti soup: the complex worlds of food waste behaviour"

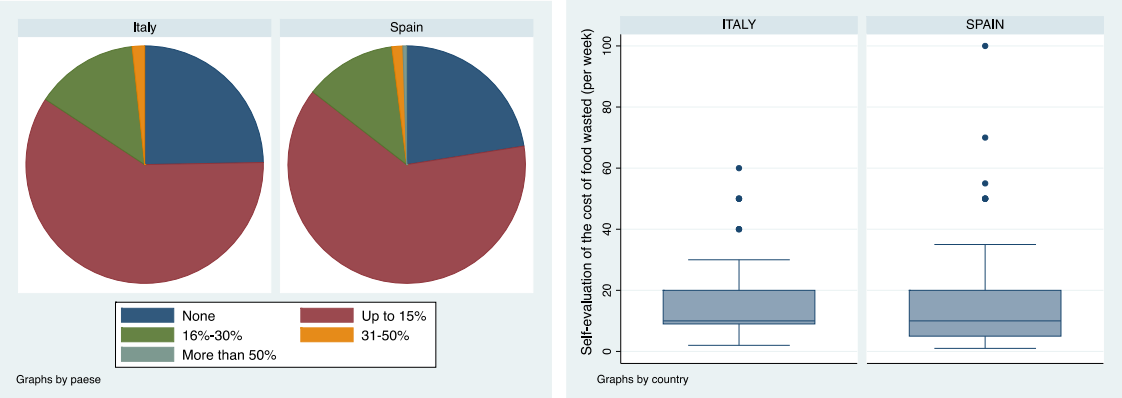
[3] This research hypothesis can be distinguished into: R*H3.1.*: The direct relationship between Subjective norms and Positive behaviour is mediated by Intention; R*H3.2*: The direct relationship between Perceived behavioural control and Positive behaviour is mediated by Intention. *H3.3.*: The direct relationship between Subjective norms and Positive behaviour is mediated by Intention. R*H3.4.*: The direct relationship between Subjective norms and Positive behaviour is mediated by Intention.

FW impacts as well as their personal and household habits. Section 2 focuses on analysing their purchase habits and includes questions concerning the percentage of FW as well as of the foods most likely to be wasted. Section 3 includes questions regarding FW personal attitudes, intention and behaviour, while section 4 contains questions on the socio-demographic characteristics of the respondents and their households. The respondents were asked to indicate their level of agreement to the statements according to a 5-point Likert scale with categories ranging from strongly disagree (1) to strongly agree (5), except for the questions in section 4 and questions which required purely quantitative replies.

The participants were asked to indicate the percentage of food they generally waste peer week[4]. Figure 1 shows the distribution of responses for Italian and Spanish youths, respectively. 59% of the Italian youths involved in the survey stated that in his/her own household waste 15% or less of edible food is wasted while 63% of the Spanish participants declared to waste 15% or less of the food they purchase per week. 2% of Spanish youths and 1.7% of Italian youths declared that they waste more than 30% of their food.

Participants were also asked to self-estimate the economic value of the food they wasted per week. The Italian students estimated that the average value of food wasted is equal to 15.90 Euros (st.dev. 12.18) while Spanish students estimated the value of food wasted approximately equal to 13.5 Euros (s.d. 14.72) per week. We also computed the percentage of the amount spent for food that goes to waste. In fact a question in the survey was focused on the weekly household food budget which was equal to 117.52 Euros (s.d. 68.61) for Italian youths and 99.31 Euros (s.d. 72.08) for the Spanish participants. For each individual, we computed the ratio between the estimated economic value of the food wasted and the amount spent for food per week and we observed that approximately 15% of the weekly food budget goes to waste in both countries.

Figure 1: (a) Proportion of food that goes to waste per week; (b) self-evaluation of the value of food wasted (per week)



We also investigated the main types of food wasted by students. Table 1 shows the percentage of each type of food that the respondents declared to waste "at least once per week". Fruit, vegetables and bread (perishable foods) are the main types of food wasted in both Italy and Spain. However some differences between the two countries were observed since a higher percentage of Italian students declared to waste "pasta" at least once per week (21.32% in Italy and 10.90% in Spain) while a higher percentage of Spanish students declared to waste convenience food.

[4] By asking the respondents "Can you estimate what percentage of the food you buy goes to waste?", this study focuses on edible food waste.

Table 1. Food wasted "*at least once per week*" (percentage values)

Type of food	Italy	Spain
Milk	4.42	3.84
Dairy products (fresh cheese, mozzarella, etc.)	3.68	3.20
Cheese	2.21	4.49
Yogurt	5.15	7.69
Red meat (beef, veal, etc.)	2.21	5.77
White meat (turkey, chicken, rabbit)	7.36	14.75
Processed meat (sausages, ham, salami, etc.)	2.21	7.69
Fish	0.74	5.77
Legumes	0.00	3.20
Vegetables	33.82	25.00
Fruit	41.91	37.82
Bread	36.03	38.46
Pasta	21.32	10.90
Eggs	16.18	10.25
Butter and other fats	0.74	3.84
Convenience foods	2.94	12.82
Precooked foods	2.94	12.18
Frozen foods	1.48	3.85
Salted Snacks	9.56	15.38
Sweet Snacks	2.21	3.20

3.2. Modelling FW within the PLS-SEM approach

According to the TPB framework, we modelled individual behaviour towards FW by referring to the PLS–SEM statistical approach.
The PLS path modelling is a variance-based technique recommended during the first stages of research in order to test and validate exploratory models. PLS-SEMs have been widely used for modelling consumer attitudes and behaviour towards various types of waste as well as environmentally-friendly behaviour. In fact, it may be difficult to measure specific attitudes and behaviour directly while it is easier to identify a set of proxy variables (i.e. indicators) that can be used to measure behaviour indirectly thus defining it as a latent composite construct.
A PLS path model consists in two components. Firstly there is a structural model (the inner model) which illustrates the specified constructs and focuses on the relationships (paths) between them. Secondly, the measurement models (the outer models) show the relationships between the constructs and the indicators also known as manifest variables. Moreover, while structural and measurement models are present in all types of SEMs with latent constructs, the weighting scheme represents the third specific component of the PLS approach (Monecke and Leisch, 2012) and is used for estimating the inner weights linking latent constructs.

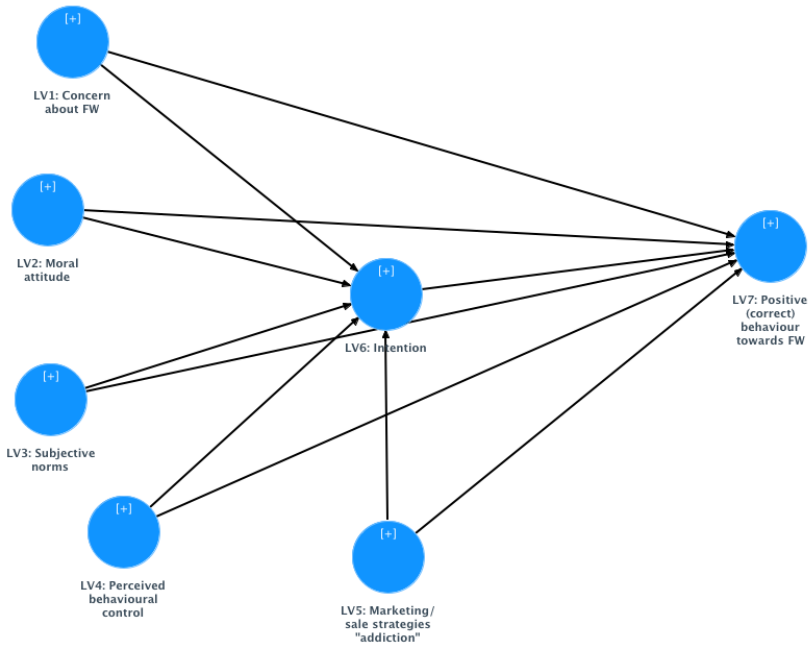
Table 2 illustrates the Latent Variables (LVs) specified in our structural model (first column) and the related indicators in the measurement model (second column) for each of them.

Table 2. Latent variables and manifest variables

LATENT VARIABLE	MANIFEST VARIABLES (INDICATORS)
LV1: **CONCERN ABOUT FW**	Q1.A I believe that the phenomenon of food waste is widespread Q1.B I think that in the current economic situation reducing food waste is a useful solution for dealing with the crisis Q1.C From a social point of view, in my opinion reducing the amount of food thrown away is a correct behaviour towards those who have no food
LV2: **MORAL ATTITUDE**	Q12 - I would waste less food if I had: b) more information on how to store food correctly c) availability of recipes (tips) on how to reuse leftovers d) more information on food freshness g) availability of smaller packages of food in stores h) greater attention from local institutions on FW and its impacts
LV3: **SUBJECTIVE NORMS**	Q1.H In my family waste separation is regularly carried out Q1.I In my family shopping list are regularly prepared before shopping
LV4: **PERCEIVED BEHAV. CONTROL**	Q13.A Even if I wanted to, it would be impossible for me to reduce the amount of FW in my household (reversed) Q14.F I can personally cook and prepare meals for my family
LV5: **MARKETING/SALE ADDICTION**	Q14.G The layout of the products in supermarkets make me purchase unnecessary items Q14.H Food packaging influences my purchases Q14.I Special offers in supermarkets make me buy more food than necessary
LV6: **INTENTION**	Q13.D In the next few weeks I intend to reduce the amount of food wasted by paying more attention to my purchases. Q13.E In next few weeks I intend to reduce the amount of food wasted by paying more attention to my portions Q14.B. I will find out in more detail the real environmental, economic and social impacts caused by FW
LV7: **POSITIVE BEHAVIOUR**	Q14.A I regularly use leftovers in the following days Q14.C I am aware of the differences between “use by” and “best before” dates Q14.D I regularly plan my purchases by writing a shopping list

Latent variables can be divided into endogenous and exogenous depending on whether they have any predecessor in the structural model or not. Figure 2 illustrates the structural model specified in our analysis together with the relationships between the latent variables.

Figure 2. The specified structural (inner) model



Intention and Positive behaviour are the endogenous variables, whose equations can be expressed as follows:

$$LV_6 = \beta_{11}\mathrm{LV}_1 + \beta_{21}\mathrm{LV}_2 + \beta_{31}\mathrm{LV}_3 + \beta_{41}\mathrm{LV}_4 + \beta_{51}\mathrm{LV}_6 + \mathbf{z}_1 \quad [1]$$

$$LV_7 = \beta_{12}\mathrm{LV}_1 + \beta_{22}\mathrm{LV}_2 + \beta_{32}\mathrm{LV}_3 + \beta_{42}\mathrm{LV}_4 + \beta_{52}\mathrm{LV}_5 + \beta_{61}\mathrm{LV}_6 + \mathbf{z}_2 \quad [2]$$

where LV_g denotes the latent variable g (g=1,…,7), the coefficient β_{gr} denotes the generic coefficient β describing the relationship between the latent variable (with g as the number of LV and r as the number of the arrow starting from LV_g) while **z** are the error terms assumed to be centred around zero, i.e. $E(\mathbf{z}) = 0$.

In the measurement model, the indicators are connected to the LVs according to a reflective scheme (i.e. the direction of the arrows goes from the LVs to its indicators). This technique is useful when concepts are abstract or when the current knowledge or data only allows for imperfect empirical representations (Ferrari et al., 2010; Secondi et al., 2011). Each block of manifest variables (indicators) contained in the data matrix **X** reflect its LV and can be written as multivariate regression models:

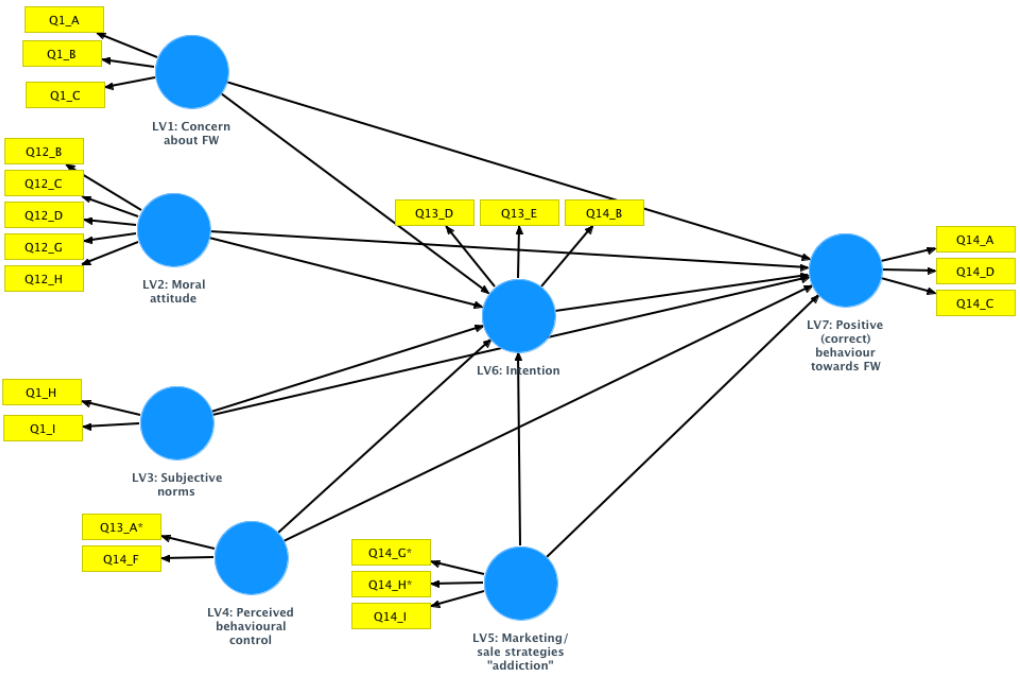
$$\mathbf{X}_g = \mathbf{LV}_g \mathbf{w}_g^T + \mathbf{F}_g \qquad E(\mathbf{F}_g | \mathbf{y}_g) = \mathbf{0} \quad [3]$$

so w_g^T can be estimated by Least Squares as (Moneche and Leisch, 2012)[5]:

$$\begin{aligned} w_g^{*T} &= \left(\mathbf{LV}_g^T \mathbf{LV}_g\right)^{-1} \mathbf{LV}_g \mathbf{X}_g \\ &= VAR\left(\mathbf{LV}_g\right)^{-1} COV\left(\mathbf{LV}_g, \mathbf{X}_g\right) \end{aligned} \quad [4]$$

Figure 3 illustrates our complete (inner and outer components) specified model which reflects the RHs specified in section 2.3. In order to test the model we used SmartPLS 3 software and applied the path weighting scheme.

Figure 3 - The specified inner and outer models



[5] The following assumption are retained to be valid in the measurement model: i) all indicators contained in the data matrix **X** are scaled to have zero mean and unit variance. Each block of manifest variables (indicators) $\mathbf{X}_g$ is already transformed to be positively correlated for all LV_g (g=1,…G).

It is worth noting that we excluded 18 individuals (7 in Italy and 11 in Spain) from the analysis since they declared that they never made purchases for their household.
We also introduced variables related to the demographic and economic characteristics of the households (number of household members and income) as well as the country of residence (Spain or Italy) in the models which did not have significant effects.
The results reported in the following section comply with recent guidelines for PLS-SEM (Hair et al, 2014; Sarstedt et al., 2014) and evaluate the measurement and structural models before illustrating the estimates in detail.

4. Results

4.1. Measurement and structural models assessment

Two stages must be carried out in order to evaluate PLS-SEM results. Firstly, we examined the measurement models by evaluating item and construct reliability, and the convergent and discriminant validity of the constructs. Secondly, we evaluated the structural model by verifying its ability to predict the endogenous constructs in terms of goodness of fit, cross-validated redundancy and path coefficients.
The reflective measurement models were evaluated for reliability and validity (Table 3). Item reliability was assessed by considering standardized outer loading greater or slightly lower than 0.70. We also retained three strategic indicators with outer loadings between 0.50 and 0.70 by verifying whether deleting these indicators lead to an increase of composite reliability or Average Variance Extracted (AVE), as suggested by Hair et al. (2014).

Table 3. Reflective models: reliability measurements

Construct	Measures	Item reliability	Composite reliability	AVE
LV1: CONCERN ABOUT FW			0.751	0.502
	Q1_A	0.703		
	Q1_B	0.669		
	Q1_C	0.751		
LV2: MORAL ATTITUDE			0.834	0.504
	Q12_B	0.754		
	Q12_C	0.762		
	Q12_D	0.788		
	Q12_G	0.558		
	Q12_H	0.664		
LV3: SUBJECTIVE NORMS			0.705	0.563
	Q1_H	0.523		
	Q1_I	0.923		
LV4: PERCEIV. BEHAV. CONTROL			0.695	0.533
	Q13_A*	0.688		
	Q14_F	0.770		
LV5: MARKET./SALE STRAT.ADDICTION			0.862	0.675
	Q14_G*	0.837		
	Q14_H*	0.857		
	Q14_I*	0.769		
LV6: INTENTION			0.834	0.627
	Q13_D	0.802		
	Q13_E	0.807		
	Q14_B	0.765		
LV7: POSITIVE BEHAVIOUR			0.739	0.497
	Q14_A	0.702		
	Q14_C	0.510		
	Q14_D	0.858		

The AVE values, defined as the grand mean of the squared loadings of the indicators associated with the construct, approximately equal to 0.50 or greater indicate convergent validity for all the constructs. Composite reliabilities for the 7 constructs are also satisfied as the values ranged between 0.695 to 0.862.
Furthermore the discriminant validity assessed by means of the Fornell and Larcker (1981) criterion - which compares the square root of the AVE values with the latent variable correlation - was also satisfied. In fact, as shown in Table 4, the square root of the AVE of each construct is greater than its highest correlation with any other construct.

Table 4 Fornell-Larcker test of discriminant validity

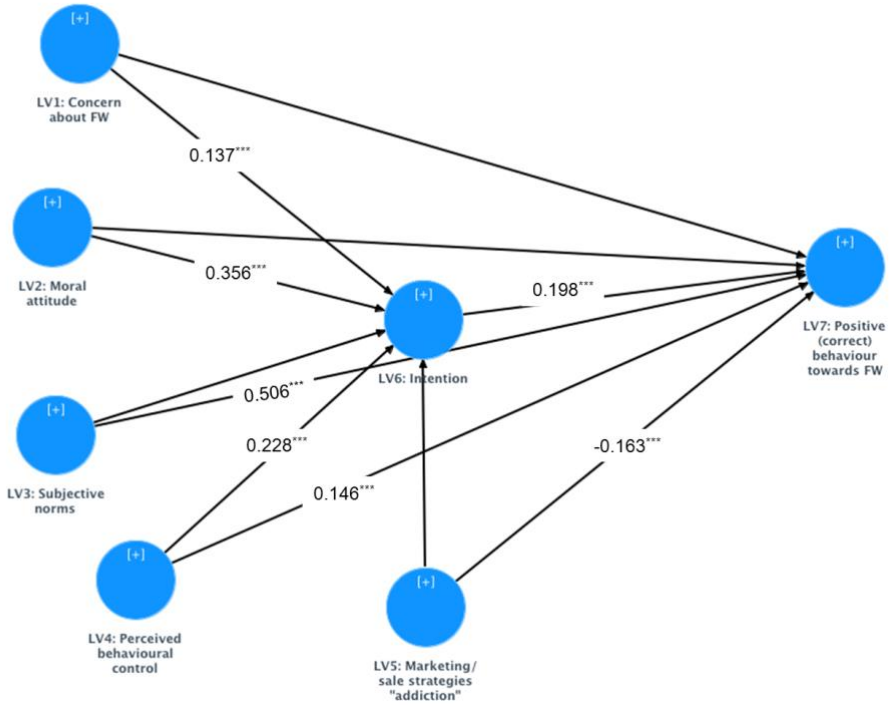
	LV1	LV2	LV3	LV4	LV5	LV6	LV7
LV1: Concern about FW	**0.708**						
LV2: Moral attitude	0.207	**0.710**					
LV3: Subjective norms	0.062	0.163	**0.750**				
LV4: Perceived behavioural control	0.152	0.103	0.180	**0.730**			
LV5: Marketing/sale strategies "addiction"	-0.019	-0.062	0.116	-0.105	**0.822**		
LV6: Intention	0.246	0.408	0.109	0.288	-0.070	**0.792**	
LV7: Positive (correct) behaviour towards FW	0.069	0.141	0.527	0.303	-0.130	0.284	**0.705**

Note: squared root of the AVE (in bold)

Having confirmed that reliability and validity of the construct measures, we assessed the structural model results. Firstly we determined the presence of collinearity in the structural model. The values of Variance Inflation Factors (VIFs) provided us with the evidence that structural model results are not affected by collinearity.
Moreover, blindfolding[6] was used to assess the predictive relevance of the model for the two endogenous constructs. The Q^2 values greater than zero for both endogenous constructs (equal to 0.132 and 0.162 for the LV6 and LV7, respectively) indicate that the accuracy of our path model is acceptable. The values of the adjusted R^2, equal to 0.233 and 0.367 for the two endogenous variables Intention and Positive behaviour respectively, confirmed that moderate portions of variability were explained by our conceptual model. These results can be considered satisfactory if analyzed within the complexity of FW behaviour (Quested et al., 2013) concerning the difficulties in finding a one-fit-all theoretical framework able to include all the drivers of individual FW behaviour.
Figure 4 shows the estimation results concerning the path coefficients describing the relationships between LVs. It is worth noting that the standard errors were bootstrapped by considering 5000 sub-samples created with observations randomly drawn from the original set of data (with replacement).
The results of direct structural relationships reveal that seven out of the eleven relationships hypothesized are statistically significant at 1% level (p-value<0.01). Concern, moral attitude and perceived behavioural control play an important and significant role on Intention. On the other hand, subjective norms were not found to have a direct significant effect on forming individual intention of reducing FW while a strong significant direct effect (equal to 0.506) was estimated towards the positive behaviour.
The results also show significant effects characterising "*Intention*" and "*Marketing strategies*" which directly influence the behaviour with positive and negative relationships, respectively (estimated direct effects equal to 0.198 and -0.163).
Table 5 provides further information on the structural model by reporting all the estimated indirect and total effects.

[6] Blindfolding is a sample reuse technique that omits every d-th data point in the endogenous construct's indicators and estimates the parameters with the remaining data points. The omitted data points are considered missing values and treated according when running the PLS-SEM algorithm. The resulting estimates are then used to predict the omitted data points. The difference between the true (omitted) data points and the predicted ones is then used as input for the Q^2 measure (Hair et al., 2014). We considered d=7.

Figure 4 Estimation results – Structural Equation model



Notes: only the statistical relationships are reported. Significance level: *** p-value<0.01

Table 5 Estimated direct, indirect and total effects

	Direct effects		Indirect effects		Total effects	
	Estimate	Sign	Estimate	Sign	Estimate	Sign
LV1: Concern about FW -> LV6: Intention	0.137	***			0.137	***
LV1: Concern about FW -> LV7: Positive behaviour towards FW	-0.028		0.027	*	-0.001	
LV2: Moral attitude -> LV6: Intention	0.355	***			0.355	***
LV2: Moral attitude -> LV7: Positive behaviour towards FW	-0.042		0.070	**	0.029	
LV3: Subjective norms -> LV6: Intention	0.004				0.004	
LV3: Subjective norms -> LV7: Positive behaviour towards FW	0.506	***	0.001		0.507	***
LV4: Perceived behavioural control -> LV6: Intention	0.228	***			0.228	***
LV4: Perceived behavioural control -> LV7: Positive behaviour towards FW	0.146	***	0.045	**	0.191	***
LV5: Marketing/sale strategies "addiction" -> LV6: Intention	-0.022				-0.022	
LV5: Marketing/sale strategies "addiction" -> LV7: Positive behaviour towards FW	-0.163	***	-0.004		-0.167	***
LV6: Intention -> LV7: Positive (correct) behaviour towards FW	0.198	***			0.198	***

Notes: Significance level: *** p-value<0.01; ** p-value<0.05; * p-value<0.10

By analysing Table 5 the importance played by Perceived behavioural control can be seen, which directly affects both "Intention" and the "Positive Behaviour" and has gained importance due to the indirect effect. The Total Effect for this variable (LV4) on behaviour (LV7) equal to 0.191 can be computed as:

$$TE_{LV4}=DE_{LV4}+IE_{LV4}=0.146+(0.228*0.198)=0.146+0.045=0.191$$

where TE_{LV4} identifies the total effect of LV4, DE_{LV4} the direct effect and IE_{LV4} the indirect effect of LV4 via LV6 (Intention) obtained as the multiplication between the two direct effects.
Lastly, it was also observed that moral attitude and concern regarding FW have indirect significant effects on FW while no significant indirect effects were found for subjective norms and marketing/sale addiction on FW via Intention.

4.2. Mediation analysis

With the aim of addressing the RH2 and RH3 we investigated whether Intention can be considered to be a mediator of each of its components foreseen by the TPB. In other words we aim at identifying whether a direct relationship exists between each latent variable LV1-LV5 and the behaviour (LV7) and if this relationship is captured by the mediator LV6 (intention)[7]. In fact, the role of each component may not only be limited to directly influence Intention but it may also be directly related to behaviour.

The sequence of the analysis carried out for the investigation mediation effects are based on the studies carried out by Hair et al (2014) and Sarstedt et al. (2014). Considering LV1 (concern about FW) the analyses were aimed at responding to the following questions: i) is the direct effect between the LV1-LV7 significant when the mediator variable (LV6) is excluded from the PLS path model? ii) is the indirect effect obtained as the multiplication between the direct effect of LV1 and LV6 on LV7 significant after the variable has been included in the PLS path model? iii) how much of the direct effect does the indirect effect absorb? Do we have a situation of full or partial mediation?
In order to answer the first question it is necessary to exclude the LV6 (Intention) from the path model and run the bootstrapping route with the previously described specifications.

Table 6 Estimated direct effects when excluding the potential mediator "Intention"

	Direct effect	Sign
LV1 → LV7	0.004	
LV2 → LV7	0.023	
LV3 → LV7	0.529	***
LV4 → LV7	0.197	***
LV5 → LV7	-0.159	**

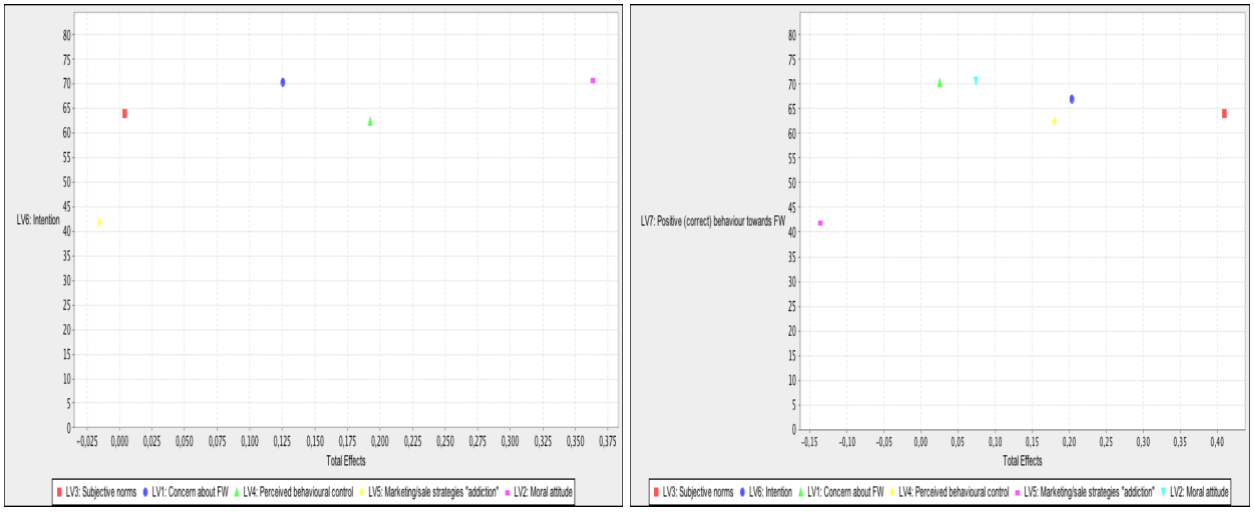
We excluded the presence of mediating effect for the LV1 and LV2 since direct effects were found to be not significant. Therefore the subsequent analysis refers to the LV3, LV4 and LV5 constructs. We then estimated the full model (i.e. with the mediator included) and we tested the significance of the indirect effect. The indirect effect of LV3 on LV7 via intention was found to be significant at 5% level.
Lastly, we computed the Variance Accounted For (VAF) as the ratio between the Indirect effect and Total effect of LV3. The result gave a value of 21.62% suggesting that Intention partially mediates (Hair et al, 2014) the relationship between Perceived behavioural control and Positive behaviour FW towards.

4.3. The Importance Performance Matrix Analysis

By extending the results of the PLS-SEM model, it is possible to construct the Importance Performance Matrix Analysis (IPMA) that graphically contrasts the total effects of the structural model assumed as measures of importance of each construct on the endogenous LVs (*x-axis*) and the average values of the LV scores assumed as measures of performance (*y-axis*). The construction of the IPMA can help to establish the level of importance and performance of each construct in order to explain our two target LVs, the LV6: *Intention of reducing FW* and the LV7: *Positive behaviour towards FW*.

[7] A complete definition of mediator variable can be found in Hair et al. (2014)

Figure 5: (a) IPMA (LV6 Intention) and (b) IPMA (LV7 Behaviour)



Notes: the x-axis displays the importance, y-axis the performance.

Figure 5a shows that when explaining the Intention a low level of importance is attributed to Marketing strategies and Subjective norms while the most important dimensions are represented by Moral Attitude and Perceived Behavioural Control.
On the other hand, according to Figure 5b, Perceived behavioural control (LV4), Intention (LV5) and Subjective Norms (LV3) represent the dimensions which greatly determine the positive behaviour.

5. Discussion and concluding remarks

Much attention has recently been paid to the association between FW behaviour at individual level and the personal as well as attitudinal variables which has produced two main results. Firstly, the generation of FW cannot be viewed as a single behaviour but as the result of multiple types of activities that increase the likelihood or amount of food wasted (WRAP, 2011a; Quested et al, 2013). Secondly, the Theory of Planned Behaviour has been recognized as an appropriate starting point for FW behaviour analysis (Ghani et al, 2013; Quested et al, 2013; Stefan et al. 2013).
Our study was focused on youths who are those who require monitoring and education in order to modify their behaviour to prevent FW. The results obtained enabled us to gain empirical knowledge on this topic by exploring "new" dimensions that should be considered when this type of behaviour is analysed as well as by assessing the existing relationships among the various dimensions (latent dimensions) that form this type of behaviour.
The complexity of individual behaviour towards FW which is described by Quested et al. (2013) as "*…the generation of food waste is not viewed as a single behaviour but as the result of multiple behaviours that can increase the likelihood or amount of food being wasted*" was considered in our study by referring to the PLS-SEM statistical approach which enabled us:

i) to jointly consider FW behaviour as the result of activities which relating to various phases of food purchase and consumption;
ii) to include our analysis within the TPB theoretical framework and empirically verify if and to what extent "complex" relationships exist between the various TPB components, Intention and positive behaviour. The TPB framework also enabled us to verify the effect of marketing and sale strategies (LV5) on both Intention and Behaviour.

Since the FW initiatives are mainly oriented to re-educate people to have a correct behaviour and instill good-practices towards planning-cooking-storing food correctly, we modelled a "latent"

behaviour towards FW as the result of three requirements which have been recognized as being the factors limiting FW since the ability of correctly distinguishing *between expiration dates*, *planning purchases before shopping* and *re-using leftovers in new meals* is considered to result in positive behaviour.
In our exploratory research we found confirmation of the important role played by behavioural theories – such as the TPB – in determining food waste generation and prevention. In fact, over a third of the variability in the youths' behaviour towards FW is explained by components related to behavioural models.
The decision of dividing attitudes towards FW into "*Moral attitude*" and "*Concern towards FW*" was confirmed by the significant role played by these two components in influencing Intention of reducing FW (LV6).
Subjective norms, expressed in terms of practices and behaviour carried out frequently and occasionally automatically in the individuals' households have a direct and positive effect on individual behaviour. We therefore believe that good examples set by the family can positively influence youths to reduce FW who will in turn set a good example for their offspring.
A crucial role is played by the individual's perceived control of his/her behaviour towards FW. As foreseen by the original scheme of the TPB (Ajzen, 1991; Armitage and Conner, 2001) we observed that Perceived Behavioural Control (LV4) has a significant effect on both Intention of reducing FW (LV6) and positive behaviour (LV7). The mediation analysis carried out within the PLS-SEM approach enabled us to establish that Intention partially captured the relationships between Perceived Behavioural Control and the positive behaviour. There is therefore a significant effect of the individuals' perception of carrying out the behaviour on the behaviour itself and not only on the intention. This result can represent a stimulus to make each individual within a household responsible for the amount of waste he/she generates. Educational programs and campaigns can be aimed at incentivize volitional control that is, when a person can willingly enact a behavior or not.
Marketing and sale strategies promoted by food companies were found to have direct significant negative effect on consumer behaviour. In fact offers, promotions, and layout of goods in supermarkets can strong influence FW generation and therefore interventions or initiative involving only consumers cannot be effective in reducing FW. This result confirming the importance of the context of purchase can enhance the literature concerning FW at consumer level and policy makers should take into account the important role of food companies and retailers when implementing FW campaigns. It is worth noting the recent initiative carried out by TESCO supermarket in UK that created the "*buy one, get one free later*" promotion, with the aim of cutting down food wastage of perishable products deriving from 2X1 offers by allowing customers to take home the second free product at a later date.

Lastly, the use of the IPMA can help to identify the dimensions which mostly contribute to the formation of positive intention and behaviour both in terms of performance and importance thus identifying dimensions on which it is advisable to concentrate in order to achieve effective results. Dimensions with a high level of performance and importance falls into the so-called "*Keep Up the Good Work*" section of the IPMA[8]. In the context of FW and related policy planning issues these dimensions includes the components which have a greater effect on individual behaviour. In our analysis we found that Moral Attitude and Perceived Behavioural Control are the main components responsible for Intention while Intention, Subjective Norms Perceived Behavioural Control are the most important determinants of positive behaviour.
On the other hand if high importance and low performance are observed for specific dimensions, this can be viewed in the "Concentrate here" section meaning that greater attention is required on these dimensions in order to contrast FW quickly and effectively.

[8] The IPMA extend the original Importance-Performance-Analysis (IPA) framework introduced by Martilla and James (1977) in marketing analysis.

Although the results of our study can inspire further research there are still some limitations to overcome. On one hand, the self-estimated measures of the amount of FW can lead individuals to bias (to under-estimate) the amount of food wasted and therefore this technique of data collection should be replaced with objective measures deriving from kitchen-diary studies in which individuals are required to weigh the food they waste. On the other hand, the data collection process and the sampling scheme adopted make our research an exploratory study thus preventing us from extending findings to the entire young population. Future studies should overcome this limitation in order to obtain a better knowledge and understanding of this phenomenon.

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